

# Whitman-Hanson Regional High School

## Whitman, Massachusetts



## Highlighting high performance

**G**reen schools present an economical solution to rising energy prices by reducing energy consumption. Whitman-Hanson is a new 234,500-ft<sup>2</sup> high school that highlights the benefits of green building design. Not only do the school's green building features save on the cost of utilities, they serve to provide a healthy and safe learning atmosphere that is essential for students.

Green features such as daylighting, a well-insulated building envelope, energy-efficient mechanical systems, a white roof, and energy-efficient appliances significantly reduce energy consumption. A 51-kW solar electric system installed on the school's roof will supply approximately 5% of the building's annual energy use. Other green features include a 20,000-gallon underground tank that collects rainwater from the roof for use in flushing toilets and urinals. In addition, many site features such as existing paved surfaces and existing athletic fields were incorporated into the final design to minimize the impact of the new building.

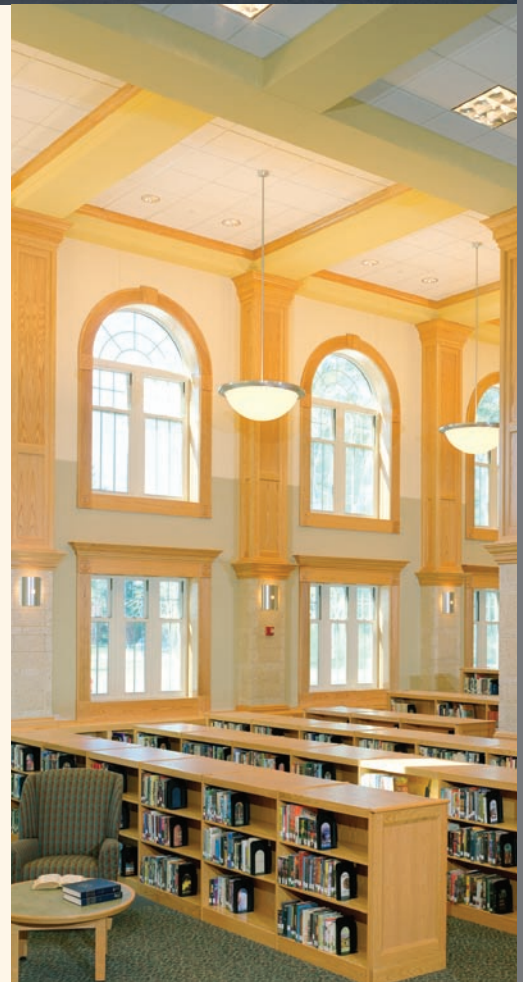
The school's design takes advantage of natural light, which reduces the need for traditional electric lighting. The library, a two-story lecture hall, the classrooms, a performing arts center, and a double gymnasium all use natural light and

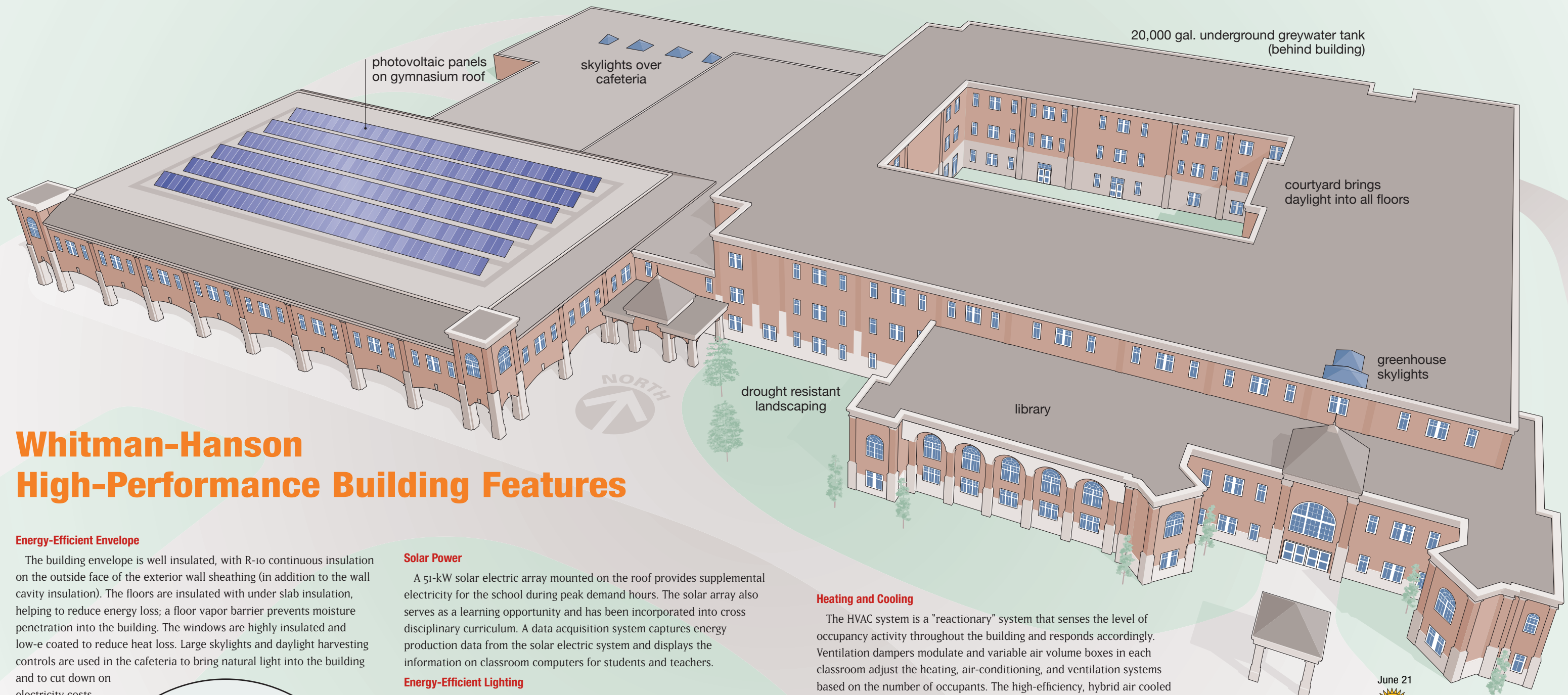
daylight sensors to improve energy savings. Large skylights and daylight harvesting controls in the cafeteria are also used to reduce energy consumption.

The school uses the money it is saving on energy to purchase high-tech (state of the art) educational aids. Examples of items include built-in facilitator stations, interactive white boards, and LCD projectors for all classrooms. Other teaching aids such as a distance learning center, cyber cafes, instruction kiosks, and smart conference rooms with plasma screens also contribute to student learning.

The school is a pilot project for the Massachusetts Green Schools Initiative, a partnership between the Massachusetts School Building Authority and the Massachusetts Technology Collaborative. Through technical assistance and financial incentives offered under the Green Schools Initiative, the towns of Whitman and Hanson built an affordable school that conserves energy while enhancing the teaching and learning environment.

**Green features such as natural light (shown in library at right) help to offset electrical lighting loads at the school. Features such as these are predicted to save 39% in energy costs beyond code. Predicted avoided energy costs are \$100,000 per year.**

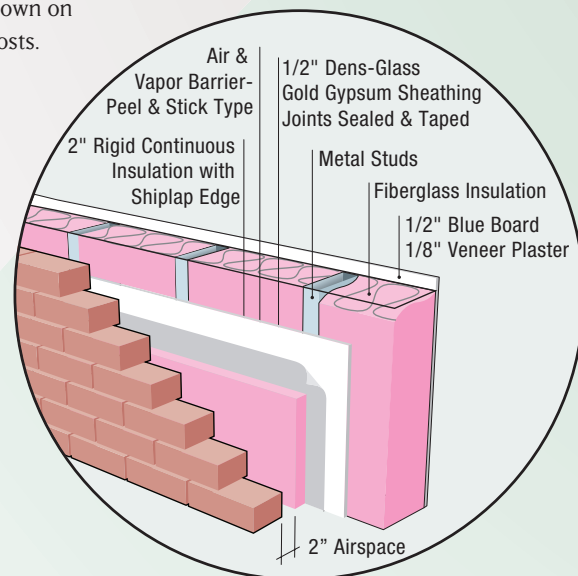




# Whitman-Hanson High-Performance Building Features

## Energy-Efficient Envelope

The building envelope is well insulated, with R-10 continuous insulation on the outside face of the exterior wall sheathing (in addition to the wall cavity insulation). The floors are insulated with under slab insulation, helping to reduce energy loss; a floor vapor barrier prevents moisture penetration into the building. The windows are highly insulated and low-e coated to reduce heat loss. Large skylights and daylight harvesting controls are used in the cafeteria to bring natural light into the building and to cut down on electricity costs.



## Solar Power

A 51-kW solar electric array mounted on the roof provides supplemental electricity for the school during peak demand hours. The solar array also serves as a learning opportunity and has been incorporated into cross disciplinary curriculum. A data acquisition system captures energy production data from the solar electric system and displays the information on classroom computers for students and teachers.

## Energy-Efficient Lighting

High-efficiency fluorescent fixtures, including pendant-mounted, direct-indirect lighting fixtures, are used throughout the building. The average lighting power density of the entire building is 1.15 W/ft<sup>2</sup>, which is 23% more efficient than the applicable code at the time the building was constructed. Daylighting and daylight sensors are used in each classroom and in the gymnasium to reduce energy use from electrical lighting by dimming the lights when enough daylight is present. Windows are designed to allow natural light to penetrate further into building spaces.

## Water Conservation

A 20,000-gallon underground greywater storage tank collects rainwater runoff from the roof and reuses it to flush toilets and urinals in the school. Low flow toilets and sinks with automatic controls also help reduce water use. Native plants that are tolerant of most Northeast weather patterns were selected to eliminate the need for landscape irrigation. These efficient features will provide the school 38% savings on water use compared to a code compliant school.

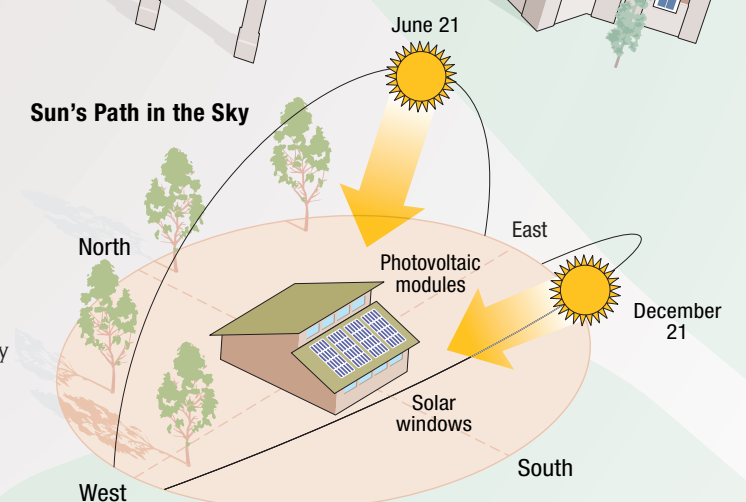
## Heating and Cooling

The HVAC system is a "reactionary" system that senses the level of occupancy activity throughout the building and responds accordingly. Ventilation dampers modulate and variable air volume boxes in each classroom adjust the heating, air-conditioning, and ventilation systems based on the number of occupants. The high-efficiency, hybrid air cooled and evaporative cooled chiller system significantly reduces energy consumption because it was designed according to the building occupancy schedule. Other energy-saving features include high efficiency condensing boilers that convert much more fuel into heat compared to conventional types, demand controlled ventilation with an energy recovery system, and variable flow pumping which reduces pump power at part-load conditions.

## Site Orientation

The building's orientation makes the most of the thermal energy of the sun and the natural light; it maximizes classroom daylight, increases energy savings, controls erosion, and minimizes light pollution. Careful consideration was given to preservation of existing trees, existing wind patterns, and sensitivity to wetlands. Proper site orientation drove the architect's decisions about main entry placement, percentage and density of building façade glazing, classroom orientation, location of skylights, percentage of paved surfaces, and preservation of existing trees. In addition, the two-story construction reduced the building footprint.

## Sun's Path in the Sky



In winter, south-facing windows accept direct sunlight to light and warm the space. In summer, south-facing windows accept indirect sunlight (overhangs divert direct sunlight) to light the building interior without heating it.

# Green Schools Initiative

The goal of the Green Schools Initiative is to design and build schools that offer productive learning environments, save money, and are resource efficient. It encourages school districts in Massachusetts to construct or renovate school buildings that cost less to operate through energy and water conservation and renewable energy measures while providing a healthy setting for students. The Massachusetts Technology Collaborative (MTC) and the Massachusetts School Building Authority are partners in this initiative; they work as a team to provide school districts in the state with the information and resources necessary to design and build high-performance schools. The initiative provides:

- The Massachusetts High Performance Green Schools Guidelines (MA-CHPS) — Planning Guide and Criteria Document
- Information about utility rebate programs and MTC grants
- Technical assistance
- Studies and reports for comparison information



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**Daylighting with highly reflective surfaces is used in the classrooms, library, and cafeteria to offset electrical lighting loads and reduce energy consumption.**

**Photo Credits: All photos by Bruce T. Martin**

## Green Building: First Costs versus Life-Cycle Savings

Incorporating smart energy saving design and energy-efficient technologies into buildings can yield impressive long-term savings, despite higher first costs. The long-term savings result from lower electricity, heating, cooling, and water costs as well as lower operation and maintenance costs. The first costs of some green buildings are comparable to or less than the cost for conventional construction because of resource efficiency and correctly sized mechanical, electrical, and structural systems. Thus, if you exclude the solar electric generation system and all of the incentives, Whitman-Hanson had less than a nine-year payback to build green.

The total construction cost for Whitman-Hanson was \$41 million. Incorporating the green technology was 2.83% of total construction costs or an incremental cost of \$4.85/ft<sup>2</sup> without incentives, but the life-cycle benefits outweigh the first costs, especially when incentives are considered. Whitman-Hanson received more than \$1.1 million in total incentives from both the local utility companies and a state incentive of 2%. The benefit to cost ratio for Whitman-Hanson to build green, excluding renewable energy generation systems and any incentives, was 2.32, which corresponds to less than a nine-year payback. As it turns out, when Whitman-Hanson included incentives, which were used to cover all of their associated incremental first costs, the payback for these green features is essentially immediate. The cost of the solar electric system was \$580,000 and most of this was paid for by a \$475,000 construction grant from MTC.

### Life-Cycle Savings for Whitman-Hanson High School

Estimated energy savings	\$100,000/year
Estimated electricity from renewable energy	62,000 kWh/year
Estimated energy use savings beyond code	39%
Estimated water savings	603,540 gallons/year

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### More Information

MTC Green Schools Initiative  
[www.masstech.org/RenewableEnergy/green\\_schools.htm](http://www.masstech.org/RenewableEnergy/green_schools.htm)

National Review of Green Schools: Costs, Benefits and Implications for Massachusetts  
<http://masstech.org/renewableenergy/katsstudy.html>

The Costs and Benefits of Green Schools in Massachusetts  
<http://masstech.org/renewableenergy/hmfstudy.html>

Daylighting in Schools  
[www.h-m-g.com/](http://www.h-m-g.com/)

High-Performance Schools: Affordable Green Design for K-12 Schools  
[www.nrel.gov/docs/fy04osti/34967.pdf](http://www.nrel.gov/docs/fy04osti/34967.pdf)

Energy Design Guidelines for High-Performance Schools  
[www.eere.energy.gov/buildings/highperformance/design\\_guidelines.html](http://www.eere.energy.gov/buildings/highperformance/design_guidelines.html)

High-Performance Buildings Database  
[www.eere.energy.gov/buildings/database](http://www.eere.energy.gov/buildings/database)

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